Title :   Deep Learning-Based Honeybee Hive Classification

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ABSTRACT

Traditional honey assessment is typically conducted through visual inspection by farmers, which can be inconsistent due to varying levels of experience and different phases of honey production. With the growing demand for honey products, image processing offers an efficient alternative for estimating honey quantity. This study presents a machine learning based method utilizing image processing to quantify honey areas inside the red, green, and blue (RGB) images captured with a consumer-grade camera (Sony, a7R IV, 2019). Monthly image collections were conducted between July 2024 and January 2025. YOLO version 11 was applied to the 464 honeycomb images for enabling automated detection and classification of capped and uncapped honey cells. Moreover, 64.6% of honeycomb images were used to train and validate the model. For masking capped honey cells, the mean average precision (mAP) at an intersection over union at threshold of 0.5 was 80.5%. For masking uncapped honey cells, the mAP50 was 74.3%. Using bounding box detection, the mAP50 score was 80.5% for capped honey cells and achieved the highest performance for uncapped honey cells at 83.4%. This method offers a reliable, scalable solution for real-time honey quantity assessment, significantly enhancing beekeeping efficiency through automated monitoring of honey production.

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